CLAIMS

What is claimed is:

1. A structure in an integrated circuit, said structure extending from a conductive surface through a channel having inner walls extending above said conductive surface, said structure comprising:

a layer of a refractory metal residing on said conductive surface and said inner walls of said channel; and

a layer of a metal nitride residing on said layer of said refractory metal, wherein said layer of said metal nitride has a thickness extending from said layer of said refractory metal of less than 130 Å.

2. The structure of claim 1, wherein said layer of said metal nitride has a thickness in the range of 25 to 75 Å.

3. The structure of claim 1, wherein said layer of said refractory metal and said layer of said metal nitride have a combined thickness extending from said inner walls of said channel of less than 200 Å.

4. The structure of claim 1, wherein said structure has a width that is less than or equal to

3,000 Å.

5. The structure of claim 1, wherein a ratio of a height of said structure to a width of said structure is greater than or equal to 3.33.

6. The structure of claim 1, wherein said layer of said refractory metal has a thickness extending from said inner walls of said channel in a range of 25 to 100 Å.

7. The structure of claim 1, wherein said refractory metal is a metal selected from the group consisting of titanium, tantalum, cobalt and molybdenum.

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8. The structure of claim 1, wherein said metal nitride has a resistivity of less than 600 $\mu\Omega$-cm.

9. The structure of claim 1, wherein said metal nitride includes a metal selected from the group consisting of titanium, zirconium, hafnium, tantalum, molybdenum and tungsten.

10. The structure of claim 1, further including:

a layer of a metal residing on said layer of said

metal nitride.

11. The structure of claim 10 wherein said metal nitride is adhesive to said metal.

12. The structure of claim 10, wherein said metal is tungsten.

13. The structure of claim 10, wherein said structure has a resistance less than or equal to 3.0 Ω.

14. The structure of claim 13, wherein said channel has an aspect ratio grater than or equal to 3.33.

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15. A structure in an integrated circuit, said structure extending from a conductive surface surrounded by a channel having inner walls extending from said conductive surface, said structure comprising:

a layer of a refractory metal having a thickness in a range of about 25 to 100 Å residing on said conductive surface and said inner walls of said channel; and

a layer of a metal nitride residing on said layer of said refractory metal, wherein said layer of said

metal nitride has a thickness extending from said layer of said refractory metal of less than 130 Å.

16. The structure of claim 15, wherein said layer of said metal nitride has a thickness in the range of 25 to 75 Å.

17. The structure of claim 15, wherein said layer of said refractory metal and said layer of said metal nitride have a combined thickness extending from said inner walls of said channel of less than 175 Å.

18. The structure of claim 15, wherein said channel has an aspect ratio greater than or equal to 3.33.

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19. The structure of claim 15, wherein said refractory metal is a metal selected from the group consisting of titanium, tantalum, cobalt, and molybdenum.

20. The structure of claim 15, wherein said metal nitride includes a metal selected from the group consisting of titanium, zirconium, hafnium, tantalum, molybdenum and tungsten.

Sub C1

21. A method for forming a structure in an integrated circuit, said structure extending from a conductive surface through a channel having inner walls extending above said conductive surface, said method including the steps of:

(a) depositing a layer of a refractory metal on said conductive surface and said inner walls of said channel; and

(b) forming a layer of a metal nitride on said layer of said refractory metal, wherein said layer of said metal nitride has a thickness extending from said layer of said refractory metal of less than 130 Å.

22. The method of claim 21, wherein said layer of said metal nitride has a thickness in the range of 25 to 75 Å.

23. The method of claim 21, wherein said layer of said refractory metal and said layer of said metal nitride have a combined thickness extending from said inner walls of said channel of less than 200 Å.

24. The method of claim 21, wherein said step (b) includes the steps of:

depositing said metal nitride on said layer of said refractory metal~~; and~~

plasma annealing said metal nitride.

Sub C2

25. The method of claim 24, wherein said step of plasma annealing includes the steps of:

exposing said metal nitride to an environment containing ions; and

electrically biasing said layer of said metal nitride to cause said ions from said environment to impact said metal nitride.

26. The method of claim 25, wherein said step of exposing said metal nitride to said environment containing ions includes the steps of:

providing a gas; and

providing a first rf signal to a first electrode on a first side of a wafer on which said structure is being formed to provide energy to said gas.

27. The method of claim 26, wherein said gas contains at least one gas selected from the group consisting of nitrogen, hydrogen, argon, helium, and ammonia.

28. The method of claim 26, wherein said metal nitride includes at least one material selected from the group consisting of titanium, tantalum, tungsten,

hafnium, molybdenum, and zirconium.

29. The method of claim 26, wherein said gas includes a noble gas.

Sub C3

30. The method of claim 24, wherein said step of depositing said metal nitride and said step of plasma annealing are both performed in a single chamber and without removing a wafer on which said structure is being formed from the chamber between beginning said step of depositing said metal nitride and completion of said step of plasma annealing.

31. The method of claim 24, wherein said step of depositing said metal nitride is performed using chemical vapor deposition.

32. The method of claim 24, wherein said step of plasma annealing includes the steps of:

performing a first plasma annealing of said metal nitride; and

performing a second plasma annealing of said metal nitride after performing said first plasma annealing.

33. The method of claim 32, wherein said step of performing said first plasma annealing includes the

steps of:

exposing said metal nitride to a first environment containing ions; and

electrically biasing said metal nitride to cause said ions from said first environment to impact said metal nitride.

34. The method of claim 33, wherein said step of performing said second plasma annealing includes the steps of:

exposing said metal nitride to a second environment containing ions; and

electrically biasing said metal nitride to cause said ions from said second environment to impact said layer of said metal nitride.

35. The method of claim 34, wherein said step of exposing said metal nitride to a first environment containing ions includes the steps of:

providing a first gas, and

providing energy to said first gas to generate a first plasma, and

wherein said step of exposing said metal nitride to a second environment containing ions includes the steps of:

providing a second gas, and

providing energy to said second gas to generate a second plasma.

36. The method of claim 35, wherein said first gas contains at least one gas selected from the group consisting of nitrogen, hydrogen, argon, helium, and ammonia.

37. The method of claim 35, wherein said second gas contains at least one gas selected from the group consisting of nitrogen, helium, neon, and argon.

38. The method of claim of claim 32, wherein said step of depositing said metal nitride is performed using chemical vapor deposition.

39. The method of claim 32, wherein said step of depositing said metal nitride and said step of plasma annealing are both performed in a chamber without removing a wafer on which said structure is being formed from the chamber between initiating said step of depositing said metal nitride and completing said step of plasma annealing.

40. The method of claim 21, wherein said channel has a width less than or equal to 3,000 Å.

41. The method of claim 21, wherein said channel has an aspect ratio that is greater than or equal to 3.33.

42. The method of claim 21, wherein said refractory metal is deposited in said step (a) by physical vapor deposition.

43. The method of claim 21, wherein said refractory metal is deposited in said step (a) by chemical vapor deposition.

44. The method of claim 43, wherein said refractory metal is a metal selected from the group consisting of titanium, tantalum, cobalt, and molybdenum.

45. The method of claim 21, further including the step following said step (b) of:

(c) depositing a layer of a metal on said layer of said metal nitride.

46. The method of claim 45, wherein said metal is tungsten.

47. The method of claim 46, further including the step following said step (c) of:

(d) etching said layer of said refractory metal, said layer of said metal nitride, and said layer of said metal to decompose portions of said layer of said refractory metal, said layer of said metal nitride, and said layer of said metal that reside outside of said channel.

Sub D2

~~48. A method for forming a barrier layer over a conductive surface surrounded by a channel having inner walls extending above said conductive surface, said method including the steps of:~~

~~(a) depositing a layer of a refractory metal on said conductive surface and said inner walls of said channel to a thickness in a range of about 25 to 100 Å;~~

~~(b) depositing a layer of a metal nitride on said layer of said refractory metal; and~~

~~(c) plasma annealing said layer of said metal nitride, wherein said layer of said metal nitride has a thickness extending from said layer of said refractory metal of less than 130 Å after completing said step (c).~~

49. The method of claim 48, wherein said step (c) includes the steps of:

providing a gas;

providing energy to said gas to generate an environment containing ions; and

electrically biasing said metal nitride to cause said ions from said environment to impact said metal nitride.

50. The method of claim 49, wherein said metal nitride includes at least one material selected from the group consisting of titanium, tantalum, tungsten, hafnium, molybdenum, and zirconium.

51. The method of claim 48, wherein said step (c) includes the steps of:

performing a first plasma annealing of said metal nitride; and

performing a second plasma annealing of said metal nitride after performing said first plasma annealing.

52. The method of claim 48, wherein said channel has a width less than or equal to 3,000 Å.

53. The method of claim 52, wherein said channel has an aspect ratio that is greater than or equal to 3.33.